ADSORPTION PUMP FOR ACQUISITION AND COMPRESSION OF ATMOSPHERIC CO_2 ON MARS. Donald Rapp[1], Paul Karlmann[1], and David L. Clark[2], [1]Jet Propulsion Laboratory, Pasadena CA 91109, USA, [2]Lockheed Martin Astronautics, Denver CO, USA.

A flight-prototype zeolite adsorption compressor is being developed as a reliable, efficient, cost-effective means of extracting and compressing atmospheric CO_2 on the surface of Mars. Designed as the first stage of a Mars in-situ CO_2 to O_2 chemical conversion process, this work is part of a collaborative effort between Johnson Space Center (JSC), Jet Propulsion Laboratory (JPL), and Lockheed-Martin Astronautics (LMA).

By exposing the sorption compressor to the cold night-time environment of Mars (approx. 6 torr, 200 K), CO_2 is preferentially adsorbed from the Martian atmosphere by the zeolite sorbent material contained within. During the warmer day-time environment, when solar electrical power is available, the adsorbent is heated in a closed volume, thereby releasing CO_2 at significantly higher pressures (600–2000 torr) for use in a CO_2 conversion reactor.

An earlier prototype of this type of system was built and tested by LMA under initial sponsorship of JSC and further development sponsored by JPL. While this prototype adsorption compressor was shown to function very reliably, there are many important issues and challenges remaining in the design of a long-life, highly efficient adsorption compressor with minimum volume, mass, and power requirements. Some of these issues are:

(1) **Sorbent Material Characteristics.** What quantity of CO_2 can be adsorbed and desorbed by a given amount of sorbent material, which materials are optimal, and what operating pressures and temperatures are required?

(2) **Removal of Non-CO_2 Gases.** A system must be provided which prevents permanent gases from building up significant concentrations around the adsorbent material, thus creating a diffusive barrier to further adsorption of CO_2.

(3) **Efficient Day-time Heating.** A system must be provided to allow maximum use of waste heat from an ISRU conversion reactor by the adsorption compressor whil also providing for use of electrical power for heating the compressor when waste heat proves inadequate. To minimize input power requirements, the compressor must also be well insulated.

(4) **Night-time Cooling.** There is a significant challenge in cooling the well insulated adsorption compressor at night. Preliminary modeling shows that internal convection during adsorption is insufficient for cooling the compressor and that an external radiator/convector is necessary. Heat transfer between the sorption compressor and external radiator will require the use of a fluid loop, heat-pipes, or thermal switch device.

The purpose of this paper is to provide insights, analysis, test data and concepts which address each of the issues described above, thereby arriving at a consensus preliminary design of such an adsorption compressor for extraction and compression of atmospheric CO_2 on Mars which provides the most CO_2 for the least volume, mass and power required for the adsorption pump.